Lloyd's Register

Rules and Regulations for the Classification of Naval Ships, January 2011

Notice No. 3

Effective Date of Latest Amendments:

See page 1

Issue date: November 2011

Lloyd’s Register is an exempt charity under the UK Charities Act 1993

Lloyd's Register, its affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to in this clause as the ‘Lloyd's Register Group’. The Lloyd's Register Group assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register Group entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

RULES AND REGULATIONS FOR THE CLASSIFICATION OF NAVAL SHIPS, *January 2011*

Notice No. 3

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Naval Ships, January 2011.* The amendments are effective on the dates shown:

Volume	***Part***	***Chapter***	***Section***	***Effective date***
1	1	2	3	1 January 2012
1	3	1	3	1 January 2012
1	3	6	4	1 January 2012
1	4	1	5	1 January 2012
1	4	2	5	1 January 2012
1	6	3	12	1 January 2012
1	6	4	4	Corrigenda
2	1	1	6	1 January 2012
3	1	4	4	Corrigendum
3	1	5	1	Corrigendum
3	3	1	1, 2, 6	1 January 2012
3	3	6	5	Corrigendum

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Naval Ships, January 2011* are to be read in conjunction with this Notice No. 3. The status of the Rules is now:

Rules for Naval Ships	Effective date:	January 2011
Notice No. 1	Effective date:	1 January 2011 & Corrigenda
Notice No. 2	Effective date:	1 January 2012 & Corrigenda
Notice No. 3	Effective date:	1 January 2012 & Corrigenda

Volume 1, Part 1, Chapter 2
Classification Regulations

Effective date 1 January 2012

■ *Section 3*
Character of Classification and Class notations

3.2 Character symbols

(*Part only shown*)

3.2.5 The Navy or Naval Authority may specify alternative or additional standards~~/requirements~~ relating to the application of a character symbol or Class notation. Where these alternative or additional standards~~/requirements~~ have been agreed by LR and a formal process for approval, construction, testing and verification throughout life has been established, this feature will be recognised by the addition of **(NS)** to a character symbol or Class notation. *See also* 3.11. The alternative or additional requirements of the Navy or Naval Authority are to be clearly defined and referenced in the Classification Certificates and any required registers such as the register of lifting appliances. The following are examples of character symbols and Class notations that may recognise Navy or Naval Authority requirements as they may appear in the *Register Book*:

3.7 Military Distinction notations

(*Part only shown*)

3.7.1 Military Distinction notations may be assigned if a particular feature relating to military loads has been incorporated in the design. The requirements for all the Military distinction notations are given in Part 4.

~~**SH1**~~ **SH** **Shock enhancement notation**. This confidential notation indicates that the ship is capable of meeting, as a minimum, the local structural requirements to withstand an underwater shock compatible with a specified performance level. The strength calculations are performed using a simplified approach. The minimum local assessment may be enhanced by undertaking a more complex assessment. The performance level may be enhanced by undertaking assessment of detailed design, seat design/shock mounts, hull valve design/integration and global strength assessment.

~~**SH2** **Shock enhancement notation.** This confidential notation indicates that the ship is capable of meeting the local structural requirements to withstand an underwater shock compatible with a specified performance level. The strength calculations are performed using a finite element modal in which the shock pulse is modelled using a suitable boundary element.~~

~~**SH3** **Shock enhancement notation.** This confidential notation indicates that the ship is capable of meeting the local structural requirements to withstand an underwater shock compatible with a specified performance level. The strength calculations are performed using a hydrocode in which the shock pulse is modelled by attaching a volume of fluid to the structural model.~~

Table 2.3.1 Hull, Military and Other Class Notations (*Part only shown*)

Mandatory Notations		Other Notations		
Ship Type	Service Area	Hull Strength	Military Distinction ✠ MD	Others
See 3.4 (Select one:) **NS1** **NS2** **NS3**	*See* 3.5 (Select one:) **SA1** Service Area 1 **SA2** Service Area 2 **SA3** Service Area 3 **SA4**	*See* 3.6 **ESA1 ESA2** Extreme Strength Assessment **RSA1 RSA2 RSA3** Residual Strength Assessment **TLA** Total Load Assessment **SDA**	*See* 3.7 **IB1 IB2** Internal Air Blast **EB1 EB2 EB3 EB4** External Air Blast ~~**SH1 SH2 SH3**~~ SH Shock Enhancement **WH1 WH2 WH3** Whipping Assessment	*See* 3.9 **LAP** Lifting Appliances **TA1 TA2 TA3 TA(S)** Towing Arrangements **SD** Special Duties **CM** Construction Monitoring

3.11 Tailoring – Departures from the Rules and Rule additions

3.11.1 In general, there are different levels of deviation from the Rules:

(a) Interpretations are applied where strict compliance with a Rule requirement cannot be achieved but where the proposed arrangement clearly satisfies the intent of the Rules. The decision to apply an interpretation is at LR's discretion and will be recorded in design appraisal documentation.

(b) Exceptions or concessions are non-compliances with Rule requirements where LR is satisfied that the arrangements presented are an acceptable alternative to its Rules on the basis of a technical justification. Exceptions are normally raised by the designer or Builder and are to be agreed with the Owner and Naval Authority.

(c) Alternatives are deviations which represent a significant change to the Rule requirements. They may involve the use of an alternative standard to replace a Rule Chapter. In such cases, the (**NS**) character is to be appended to the notation, *see* 3.2.5. LR is to be satisfied that the arrangements are an acceptable technical alternative. Alternatives are normally raised by the designer or Builder and are to be agreed with the Owner and Naval Authority. A tailoring document or design statement is required to define the alternative proposal in advance of design appraisal.

3.11.2 Tailoring is to be agreed between LR and the Naval Authority. Where a departure from the Rules is not agreed by LR, an exemption is required from the Naval Authority at Board level.

3.11.3 Additions may involve the use of a standard in addition to the LR Rule requirements. In such cases, the (**NS**) character is to be appended to the notation, *see* 3.2.5. Additions are normally raised by the designer or Builder and are to be agreed with the Owner and Naval Authority. A tailoring document or design statement is required to define the addition in advance of design appraisal.

3.11.4 A technical justification is to be provided for each deviation from the Rule requirements. In some cases, a full justification, hazard analysis (HAZID) and risk assessment may be required. *See Requirements for Machinery and Engineering Systems of Unconventional Design*, Vol 2, Pt 1, Ch 5.

3.11.5 At the design stage, departures from the Rules or additional requirements may be captured in a tailoring document developed by the designer. Tailoring is defined as the process by which specific requirements of a standard, specification or similar document are selected and used to meet the needs of a project. The tailoring document should cover subjects such as:

(a) Additional standards;
(b) Additional client requirements;
(c) Additional designer requirements;
(d) Interpretations;
(e) Exceptions/non-compliances against Rules;
(f) Exceptions/non-compliances against other defined standards or design policies;
(g) Equipment and component procurement.

The tailoring document should clearly define the paragraphs of the Rules which are modified, what alternative requirements are to be used and reference to the technical justification, where appropriate. The tailoring document is to be submitted with the plans at the time of appraisal and referenced in appraisal documentation.

3.11.6 At the build and through-life stages, significant non-compliances, alternative or additional requirements will be recorded by LR as exceptions, using appropriate documentation. They will be clearly defined and referenced in the Classification Certificates and any associated registers.

Volume 1, Part 3, Chapter 1

General

Effective date 1 January 2012

■ *Section 3*
Equivalents

3.1 Alternative arrangements and ~~scantlings~~ calculation methods

3.1.1 In addition to cases where direct calculations are specifically required by the Rules, LR will consider alternative ~~arrangements and~~ scantlings which have been derived by direct calculations in lieu of specific Rule requirements. All direct calculations are to be submitted for examination.

3.1.4 Alternative arrangements or fittings which are considered to be equivalent to the Rule requirements will be accepted, in accordance with Vol 1, Pt 1, Ch 2,3.11.

3.1.6 Where items are of a novel or unconventional design or manufacture, it is the responsibility of the ~~Builder~~ designer to demonstrate their suitability and equivalence to the Rule requirements.

~~*3.1.7* Alternative arrangements which are in accordance with the requirements of a Naval Authority may be accepted as equivalent to the requirements of this Part of the Rules.~~

Volume 1, Part 3, Chapter 6

Structural Procedures for the Design, Construction and Lifetime Care of Ships

Effective date 1 January 2012

■ *Section 4* Construction Monitoring

4.1 Construction Monitoring notation – CM

~~*4.1.1* **CM** (Construction Monitoring) notation may be assigned to a ship and will be entered in the *Register Book* if extended controls on structural alignment, fit-up and workmanship standards are applied to critical areas identified by structural design assessment, specified in 2.1.1, and fatigue design assessment specified in 3.1.1, in accordance with LR approved procedures.~~

4.1.1 The Construction Monitoring (CM) notation may be assigned if extended controls on structural alignment, fit-up and workmanship standards are applied to critical areas, as identified during the design of the ship. Construction Monitoring is applied primarily to verify the quality of workmanship required to improve the fatigue resistance of critical details, though other construction quality requirements can be specified in the CM plan.

4.1.2 The fatigue life of structural details can be adversely affected by a variety of factors, including workmanship defects. Criteria for workmanship defects can be considered in the CM plan. The most common factors that impact on fatigue are:

(a) Misalignment of structural members, i.e. poor fit-up;
(b) Welding defects;
(c) Materials defects;
(d) Stress concentrations resulting from incorrect geometry of structure, inadequate plate edge finish or generally poor manufacturing;
(e) Erroneous cut-outs due to inappropriate routing of systems;
(f) Discontinuity of structural members.

4.2 Identification of critical areas

4.2.1 A critical area is generally a structurally significant item or structural joint that has been subjected to an enhanced calculation or assessment. As a consequence, the performance of the item or joint will be influenced by the workmanship and fit-up in the building yard. In some areas, where there are high cyclic stresses, an enhanced workmanship and alignment standard is required in order to achieve the specified design hull fatigue life.

4.2.2 Critical areas will be identified by LR from the following assessments:

(a) Structural Design Assessment (SDA), specified in Section 2;
(b) Fatigue Design Assessment (FDA), specified in Section 3.

The CM notation is mandatory if the SDA or FDA notations are applied.

4.2.3 Critical areas may also be identified by LR from one of the following optional assessments. In general, these will be associated with reinforcement and alignment of specific critical joints; they will not be associated with general deformation criteria:

(a) Extreme Strength Assessment (ESA), specified in Pt 6, Ch 4,3;
(b) Residual Strength Assessment (RSA), specified in Pt 6, Ch 4,4;
(c) Whipping Assessment (WH), specified in Pt 4, Ch 2,6.

4.2.4 In addition, critical areas may be identified by the designer, Naval Authority or Owner from one of the following:

(a) Known areas of high stress identified by structural engineers;
(b) Areas that have experienced failure on similar ships in service;
(c) Structures with specific alignment requirements, e.g. masts, shaft brackets.

4.2.5 The critical areas, locations and assessment criteria are to be detailed in the Construction Monitoring plan. The plan should also contain templates to be used to record specific alignment requirements. The CM plan may be supported by a high-stress key plan identifying critical regions on the ship.

4.2.6 Development of the CM plan is the responsibility of the designer; LR will identify the critical locations to be subjected to monitoring, following appraisal of the assessments identified in 4.2.2 and 4.2.3 above. In general, areas with stress ranges greater than σ_{WS}, *see* Pt 6, Ch 4,2.2.3, and areas where general or detailed fatigue analysis has been undertaken will be listed in the appraisal documentation. LR may develop the CM plan on behalf of the designer, if so requested.

4.2.7 It is recommended that the areas for Construction Monitoring be identified and the criteria developed in a workshop with the designer, Builder, Naval Authority and LR.

4.3 Construction monitoring criteria

4.3.1 Critical areas are to be assigned an alignment criterion, as given in 4.3.2 to 4.3.4, based on the significance of the item and requirement from which it was derived. LR will review and agree the criterion assigned before construction commences.

4.3.2 **Normal alignment** is assigned to structure which requires an enhanced level of survey above the normal survey requirement but does not require enhanced levels of alignment above the agreed production standard, such as the Naval Survey Guidance for Steel Ships:

(a) Structure will be inspected by the Builder, before welding, for compliance with the general shipbuilding tolerances laid down in the agreed production standard.
(b) A representative sample of alignment measurements will be undertaken by LR during the survey to confirm compliance with the agreed production standard.

(c) Where there are non-compliances, the relevant shipyard department will be requested by LR to undertake full measurements and to produce a report for review by LR which details the non-compliances.

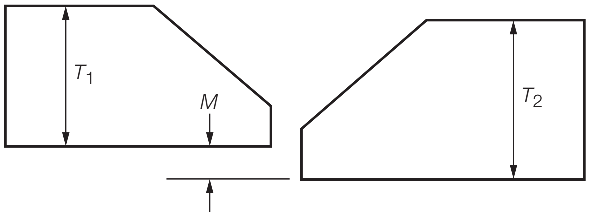
4.3.3 **Enhanced alignment** is assigned where critical areas have enhanced alignment requirements to maintain structural performance:

(a) The relevant shipyard department will be required to provide a report, based on templates in the CM plan, detailing the achieved alignment at each location.

(b) LR will review the alignment report and request check measurements as necessary to confirm the results.

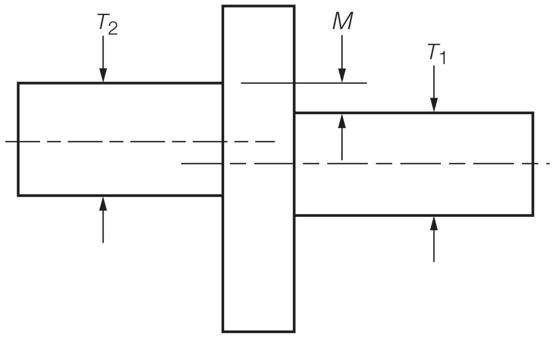
(c) The maximum allowable misalignment between the interconnection of structural members is to be 15 per cent of the thinner of the members being connected. This alignment criterion is to be applied where longitudinally effective structure is butted, e.g., plating at ring butts, longitudinal butts, *see* Fig. 6.4.1.

(d) For all cruciform joints, the maximum allowable misalignment between the interconnection of structural members is to be 20 per cent of the thinner of the members being connected. This alignment criterion is to be applied where there is alignment through a thickness, e.g., intercostal longitudinal bulkheads through a transverse bulkhead, bilge keel plate alignment with internal structure through shell plating, *see* Fig. 6.4.2.



T_1 = thickness of the thinner member
T_2 = thickness of the thicker member
M = misalignment is not to be greater than $0,15T_1$, from moulded line

Fig. 6.4.1 Alignment criterion



T_1 = thickness of the thinner member
T_2 = thickness of the thicker member
M = misalignment is not to be greater than $0,2T_1$

Fig. 6.4.2 Cruciform joints

4.3.4 **Specific alignment** is assigned where there are specific alignment criteria identified by the designer which need to be verified by LR:

(a) the relevant shipyard department will be required to provide a report detailing the achieved alignment at each location;

(b) LR will review the alignment report and request check measurements as necessary to confirm the results;

(c) the alignment criteria and templates, where appropriate, are to be defined by the designer for each critical area defined.

4.3.5 **Close-up inspection** is assigned to structure which has no specific alignment requirement but requires an increased level of inspection, for example, to verify correct plate thickness or maximum permitted plate deformation. Close-up inspection may be required to verify a particular or unusual structural feature:

(a) Structure will be subject to an enhanced close-up visual inspection by LR Surveyor(s).

(b) Dry surveys should identify where units or compartments contain construction monitoring points. These are to be identified by the Builder as a specific witness point.

4.3.6 Non-destructive examination, in addition to the general levels of NDE required in Pt 6, Ch 6, may be specified by the designer for critical areas, which LR will verify:

(a) The relevant shipyard department will be required to undertake the additional NDE required at each location and record the results.

(b) LR will review and audit the NDE measurements as necessary to confirm the results.

4.4 Construction Monitoring survey

4.4.1 Construction Monitoring is a process for monitoring workmanship standards and alignment in critical areas. It is the Builder's responsibility to carry out the necessary checks and document the results for relevant critical locations, irrespective of the Surveyor(s) attendance at hold points. Shipyard personnel are responsible for the inspection and recording of all CM requirements, in accordance with the approved CM plan.

4.4.2 LR will provide third party inspection to confirm that the critical areas to be covered by CM conform to the required/agreed standards based on check inspections and audit activities. Where LR undertakes a CM inspection to verify the implementation of the CM plan, it will cover:

(a) weld specification in terms of type, size and finish/treatment, including:
    (i) fit-up and alignment before commencement of welding;
    (ii) alignment after application of first root run;
    (iii) back gouging;
    (iv) final welding and alignment;
    (v) stress relief grinding of weld profile (where required for enhanced fatigue performance);
(b) the continuity of structural members, where required;
(c) plate edge radius and roughness;
(d) joints for radius and tapering;
(e) openings and penetrations for radius corners.

4.4.3 LR will review all of the specific CM records, as defined in 4.3, and in a few cases request that measurements be presented. It is not intended that the attending Surveyor(s) witness each stage of the fabrication process for every critical area, except during the early stages of construction whilst the process is being established.

4.4.4 CM Activities will generally be undertaken in conjunction with routine dry surveys required for all construction units. A few specific CM items require measurement by the shipyard; these are described as Enhanced or Specific Alignment.

4.4.5 Non-compliances will not be permitted in the critical areas identified within the CM plan. Where defects are identified within defined critical sections, LR is to agree the remedial action to be taken with the Shipbuilder before rectification is commenced.

4.4.6 On satisfactory completion of all surveys and measurements, LR Surveyor(s) will recommend the assignment of the CM notation.

Volume 1, Part 4, Chapter 1

Military Design

Effective date 1 January 2012

■ *Section 5*

Military design requirements

5.3 Masts and externally mounted sensors or equipment

5.3.4 The excitation of the mast by ship motions, machinery, propellers and equipment is to be specially considered and the designers calculations are to be submitted. Where possible the designer should avoid mast natural frequencies within ±20 per cent of significant global mast excitation frequencies. Where this is not possible the vibration amplitudes should be calculated to confirm they are within acceptable limits for the mast structure and equipment. In general, ship motions can be estimated from Pt 5, Ch 3,2. *See also* Pt 6, Ch 2,4. It is recommended that the frequency of the first mode of vibration of a pole mast be not less than 3,0 Hz to prevent potential excitation from the first vertical hull girder vibration mode in the range 1-2,5 Hz. The frequency of the first mode of vibration of a pole mast should be a minimum of 1 Hz above the first vertical hull girder mode.

Volume 1, Part 4, Chapter 2

Military Load Specification

Effective date 1 January 2012

■ *Section 5*

Underwater explosion (shock)

5.1 General

5.1.10 Generally, for a normal ship structure, the explosion required to cause uncontrollable flooding or total loss of propulsive power or loss of mission system effectiveness (radars, electronics, etc.) is much less than that required to cause failure of a hull designed for normal sea loads. ~~This is outside the scope of the shock notations which address structural aspects only.~~

5.2 Threat level determination

5.2.1 The level of threat required is to be specified by the Owner. ~~Three nominal levels of shock performance are presented in Table 2.5.1 together with an appropriate assessment methodology. These levels are denoted by the notations **SH1**, **SH2** or **SH3**, and are valid for a range of threat sizes. The notation that is appropriate for the level specified will be advised on request.~~ The actual threat level used in the calculation of performance and the areas of the ship to be protected by this design method are to be specified by the Owner and will remain confidential to LR.

~~*5.2.2* The actual threat level used in the calculation of performance and the areas of the ship to be protected by this design method are to be specified by the Owner and will remain confidential to LR.~~

~~**Table 2.5.1 Shock notation requirements**~~

Notation	Basic requirements	Method	Hull structure acceptance criteria
SH1	Detail design	Section 5.4 or testing/ modelling	—
	Local strength assessment	Simple empirically based assessment	Minor plate dishing within construction tolerance limits and deformation within system and equipment limits. No global strength assessment
			Some deformation of plating secondary and primary structure and deformation within system and equipment limits
	Global strength assessment	**RSA1**, **RSA2** or **RSA3** procedure, *see* Section 7	Hull girder sufficient for design bending moment with damage defined above
SH2	Detail design	Section 5.5 or testing/ modelling	—
	Local strength assessment	Fluid-structure interaction (FS1) modelling using a Finite Element and Boundary Element approach	Minor plate dishing within construction tolerance limits and deformation within system and equipment limits. No global strength assessment
			Some deformation of plating secondary and primary structure and deformation within system and equipment limits
	Global strength assessment	**RSA2** or **RSA3** procedure, *see* Section 7	Hull girder sufficient for design bending moment with damage defined above
	Shock trial	Shock trial at lower threat level	No loss of watertight integrity or hull damage
SH3	Detail design	Section 5.6 or testing/ modelling	—
	Local strength assessment	Fluid-structure interaction (FS1) modelling using a Finite Element and Volume Element approach (Hydrocode)	Minor plate dishing within construction tolerance limits and deformation within system and equipment limits. No global strength assessment
			Some deformation of plating secondary and primary structure and deformation within system and equipment limits
	Global strength assessment	**RSA2** or **RSA3** procedure, *see* Section 7	Hull girder sufficient for design bending moment with damage defined above
	Shock trial	Shock trial at lower threat level	No loss of watertight integrity or hull damage

~~*5.2.3*~~ *5.2.2* ~~Threat levels and shock performance levels are clearly closely related. No matter how well designed and inherently robust a structure and its systems are, there will be a loading level which cannot be sustained. However, there are loading levels which can be sustained~~. Loading levels may be specified with varying degrees of structural and system degradation ~~and these levels are a measure of~~ to define the shock performance of the vessel. An important consideration is the balance that has to be achieved between system functionality and structural performance.

~~*5.2.4*~~ *5.2.3* Two performance bounds can be considered for the shock response of structure:

- The first performance bound (lower bound) ~~of these would be the loading level associated with the~~ relates to the onset of material ~~failure~~ yield (assuming that careful design has ensured that no buckling ~~geometric instability~~ will occur before this state is reached). This level is useful to know as it may have consequences for system functionality. For example, there may be problems associated with equipment mis-alignment because of permanent set of the supporting structure. ~~This Section of the Rules is concerned with establishing this lower bound.~~
- The second performance bound (upper bound) relates to removal or rupture of material ~~structural integrity~~, this being the loading level at which there is no longer sufficient residual hull girder strength to resist normal environmental loading. This is addressed in a separate assessment which is defined by the residual strength notations **RSA1**, **RSA2** or **RSA3**, in Section 7. In conventional naval ships, this upper bound will be significantly higher but there will be little if any system functionality. ~~The structure is considered acceptable when the hull girder is able to withstand reduced sea loads in accordance with Pt 5, Ch 4,5.~~

5.3 Notation assessment ~~levels and~~ methodology

~~*5.3.1* Three levels of notations are given in Table 2.5.1, they represent nominal threats of increasing magnitude. For each level, there are requirements to assess the capability of the structure both locally and globally.~~

5.3.1 The shock performance required is to be agreed between the Owner, the Naval Authority and the Shipbuilder. The agreement is to include requirements for:

- Local strength assessment;
- Detailed design;
- Seat design, shock mounts and system hangers;
- Hull valve design and integration;
- Global strength assessment;
- Shock qualification/testing of equipment;
- 1st of class shock trial.

It is recommended that seats, valves and equipment are categorised into: vital, essential and non essential.

5.3.2 Ships that comply with the minimum or enhanced requirements of this Section will be eligible for the shock notation ~~**SH1**, **SH2** or **SH3**~~ **SH**.

~~*5.3.3* For ships with sea area notations **SA3**, **SA4** and **SAR**, the scantling requirements assigning a shock notation will be specially considered.~~

~~*5.3.4*~~ *5.3.3* For ships where the machinery is in class (**LMC** notation) the requirements of Vol 2, Pt 1, Ch 2,4.11 should also be complied with.

~~*5.4.2*~~ *5.3.4* ~~To achieve an adequate shock performance against a threat of this level, the~~ For the minimum shock capability, the design emphasis should focus on maintaining a high level of system functionality and reducing the risk of flooding. ~~This can be achieved by using shock mounts, rather than trying to improve the basic shock resistance of structure.~~

~~*5.4.1* The structure should be designed to resist normal environmental loads. The inherent ruggedness of the structure should be sufficient to resist a low level threat.~~

5.3.5 For the assignment of the **SH** notation, the minimum requirement is for the structure to be designed to resist normal environmental loads in accordance with the Rules. For NS1 ships, the inherent ruggedness in the Rules is sufficient for the structure to resist a low level threat. For NS2 and NS3 ships, the integrity of the hull plate and stiffeners is to be verified, using the simple formulae for pressure in 5.4.1, and comparing the response to an acceptance standard nominated by the Naval Authority. In addition, the hull valves below the waterline are to comply with the requirements of 5.8.

~~*5.3.9*~~ *5.3.6* ~~For the notation **SH2**,~~ The minimum local assessment required by 5.3.5 can be enhanced by undertaking a more complex assessment ~~method is to be used~~, as defined in 5.4, which accurately models the physics of the rapid, dynamic, fluid structure interaction problem. ~~In general, a finite element model combined with a suitable boundary element from proprietary software may be used.~~

~~*5.3.11* For the notation **SH3**, a volume of fluid is to be modelled rather than a boundary element approach using a suitable hydrocode.~~

~~*5.3.23*~~ *5.3.7* In addition to the analysis, the **SH** notation can be enhanced by selecting ~~requirements, there are~~ detail design requirements ~~for each of the levels, which are~~ to reduce the risk of fracture initiation and structural collapse, based on historical work on shock. Details are provided in 5.5. ~~Alternatives to the requirements proposed will be considered on the basis of satisfactory analysis or shock trial results.~~

~~*5.3.24*~~ *5.3.8* ~~For the higher levels, **SH2** and **SH3** there is a requirement to carry out~~ The **SH** notation may be further enhanced by undertaking shock trials in accordance with established procedures, on the first ship in the class. The magnitude of the test is normally less than the design value for the hull and at a level that is appropriate for the equipment and systems.

~~*5.3.7*~~ *5.3.9* Global assessment ~~is to be made~~ may be undertaken for the **SH** notation, using the residual strength procedures outlined in Section 7 with the extent of damage being defined from the results of the local strength assessment rather than the damage radii. For the **RSA1** procedure, the damaged structure is to be removed from the analysis. For the **RSA2** or **RSA3** procedure, if the damage is limited, the geometry of the damaged structure can be modelled and if the damage is severe, the structure is to be removed from the analysis. The structure is considered acceptable when the hull girder is able to withstand the design loads as specified in Part 5.

~~*5.3.13* The calculations are to be carried out by a competent body with experience in non-linear analysis using a suitable code. Calculations are to be carried out in accordance with established procedures, a copy of which should be made available to LR together with a list of relevant experience when calculations are to be carried out for assignment of the shock notation.~~

5.4 ~~Design guidance for level SH1~~ Local strength assessment

~~*5.3.8*~~ *5.4.1* For the notation ~~**SH1**~~ **SH,** a simple analysis ~~may~~ can be performed which allows the motion response at any point in the ship to be determined. This can be derived from experimental results or the Taylor plate equations given below. Once the motion response is known, the damage potential can be determined by comparing the response to an acceptance standard nominated by the Naval Authority.

Maximum velocity

$$V_{\max} = \frac{2P_{\mathrm{m}}}{\rho\, c}\, z^{u} \ \mathrm{m/s}$$

Time to maximum velocity

$$t_{\max} = \frac{m}{\rho\, c}\left(\frac{1}{1-z}\right)\log_e\left(\frac{1}{z}\right) \ \text{seconds}$$

where

$$z = \frac{m}{\rho\, c\theta}$$

$$u = \frac{z}{1-z}$$

θ = decay constant of explosive charge in seconds
P_{m} = peak pressure in N/mm^2
ρ = density of water in kg/m^3
c = speed of sound in water in m/s
m = structural mass per unit area in kg/m^3.

5.4.2 A more complex assessment method can be used to enhance the **SH** notation. Methods can be used which accurately model the physics of the shock event. At the simplest level, a finite element model of the structure coupled with a suitable boundary element from proprietary software may be used.

~~*5.3.10*~~ *5.4.3* For complex ships such as multi-hull designs a boundary element approach may not be suitable and a ~~**SH3** analysis would have to be performed~~ volume element approach should be used. Also, if non-linear fluid behaviour is important (i.e. hull cavitation or bulk cavitation) then a ~~**SH3** analysis would have to be performed~~ volume element approach should be used, unless the finite element or boundary element code used has a suitable cavitation model.

~~*5.3.6*~~ *5.4.4* The assessment method or analysis used should be validated against shock trial results and the evidence made available. As an alternative to analysis, full or large-scale shock trials of a section of the ship can be used to validate the proposed design. For novel design arrangements or ship types, a combination of trials and analysis may be necessary, the requirements of which will depend on the threat level and type of structure or ship design.

~~*5.3.12*~~ *5.4.5* ~~For **SH2** and **SH3** notations, the~~ Any finite element analysis performed for local strength assessment is to ~~should~~ be in accordance with the requirement of this Section for assignment of the **SH** notation.

~~*5.3.14*~~ *5.4.6* The extent of the analysis model is to be from about 0,35L_{R} to 0,55L_{R} and encompass at least two major compartments and three watertight bulkheads. It is to be sufficiently large to avoid reflections within the structure from the boundaries, for the threats considered. For the assessment of structural strength, the structure need only be modelled to 1,0 m above the design water line. If the model is to be used to determine equipment response, all structure within that section should be modelled.

~~*5.3.15*~~ *5.4.7* The model, or versions of the model, should encompass representative integral tank arrangements and hull penetrations, ~~stabilisers~~ stabiliser inserts, hull valves, the failure of which could lead to uncontrollable flooding. Penetrations, the failure of which will not lead to significant flooding or damage, need not be considered. The tanks and penetrations need not actually be in~~side~~ the section under consideration but should be sufficiently similar to represent structure outside the region modelled.

~~*5.3.16*~~ *5.4.8* All masses above 100 kg should be included in the model together with an approximation of the mounting system if applicable.

~~*5.3.17*~~ *5.4.9* The model should include at least one major machinery item or raft.

~~*5.3.18*~~ *5.4.10* The response of hull panels depends upon a large number of variables which are both design and attack geometry dependent. To simplify the task, the following assumptions can be made:

- The charge detonates in the worst location, perpendicular to the structure under consideration.
- All welding is continuous and there are no manufacturing or material defects in the panels.

~~*5.3.19*~~ *5.4.11* During the analysis, appropriate elements are to be used to couple the fluid medium and the structural model.

~~*5.3.20*~~ *5.4.12* The shock wave can be represented by an exponentially decaying, infinite rise time pressure pulse which sweeps across the structure at the speed of sound.

~~5.3.21~~ 5.4.13 Non-linear structural modelling can be ~~accommodated in **SH2** and **SH3**~~ used in finite element analyses. ~~In such cases~~ If used, stiffeners should be modelled explicitly using shell elements of the appropriate thickness. Stiffener flanges should be modelled with at least two elements per half width or flange. Initial imperfections in the hull plating are to be taken into account prior to the dynamic loading analysis.

~~5.3.22~~ ~~Initial imperfections in the hull plating are to be taken into account prior to the dynamic loading analysis.~~

~~5.3.5~~ 5.4.14 ~~Local assessment is to be carried out using an analysis method appropriate to the threat level as defined in Table 2.5.1. The global assessment need only be performed if significant permanent deformation occurs that could compromise global strength, generally, deflections of plating, secondary or primary structure significantly in excess of normal constructional tolerances.~~ The structure is considered acceptable when:

- Elastic deflections are less than the temporary limits of machinery and systems.
- Permanent deflections are less than the limits of machinery and systems.
- Deflections and strain are less than the limits of the structure or applicability of the analysis method.

5.5 ~~Design~~ Detail design guidance ~~for level SH2~~

5.5.1 For enhanced shock performance, any of the following design details can be included in the design, which is based on historical shock testing and experience.

Existing paragraphs 5.5.1 *to* 5.5.5 *have been renumbered* 5.5.2 *to* 5.5.6.

~~5.5.6~~ ~~For structure supporting seatings of equipment above 100 kg, calculations demonstrating the capability of the tank and supporting structure are to be submitted.~~

Existing paragraphs 5.5.7 *to* 5.5.17 *are to remain the same.*

5.5.18 Where the vessel is to be subjected to very high levels of shock, the following details can be included in the design.

~~5.6.1~~ 5.5.19 Pillar bulkheads are to be used below the waterline in place of pillars.

~~5.6.2~~ 5.5.20 It is recommended that symmetric stiffeners should be fitted to the underwater portion of the shell envelope.

~~5.6.3~~ 5.5.21 Where a transverse framing system is used, the shock capability of the structure will be specially considered. Calculations supporting the use of particular design details are to be submitted.

~~5.6.4~~ 5.5.22 All bulkhead stiffeners are to end on longitudinals, *see* Fig. 2.5.2. An increased thickness margin strake on bulkheads of thickness not less than 80 per cent of the adjacent shell plate thickness, the thickness of the adjacent shell stiffener or 6,5 mm. The margin plate is to have a width not less than 1,5 times the adjacent stiffener spacing or four times the depth of adjacent shell stiffeners.

~~5.6.5~~ 5.5.23 Shell frames and deck beams are to be fitted in such a way as to minimise misalignment. The frames are to be fitted within a tolerance of $0{,}3t_{fl}$ median line up to a maximum of 3,0 mm where t_{fl} is the greater thickness of the frames being connected. Where this is not possible, the frame is to be released over $20t_{fl}$ and realigned.

~~5.6.6~~ 5.5.24 Where brackets are fitted, similar tolerances to 5.5.23 are to be applied subject to a suitable area being provided for weld fillet, *see* Fig. 2.5.3. Tripping brackets or intercostal stiffeners should be used to stabilise the frame at the bracket toes. Brackets are to be radiused and fitted with soft toes.

5.5.25 The cross-sectional area of the bulkhead stiffeners at their outer ends in way of the margin plate should not be less than 60 per cent of the area of the web of the hull longitudinals to which they are attached. To achieve this requirement, the bulkhead stiffeners may be tapered between the outer end and the point at which the size is the minimum required to withstand lateral pressure. The slope of the taper is to be such that:

$$A_x > 0{,}6A_L - 2t_x/3$$

where

A_x = cross-sectional area of the bulkhead stiffener at a distance x from its outer end

A_L = web area of the longitudinal, and t is the bulkhead plating thickness at x.

5.5.26 The short stiffeners above the turn of bilge should be on the same side of the bulkhead as the main bulkhead stiffeners and should end on such a stiffener, *see* Fig. 2.5.2. Where necessary, an additional diagonal stiffener may be worked to facilitate the arrangement.

5.6 ~~Design guidance for level SH3~~ Seat design

5.6.1 The shock notation may be enhanced by specifying that some or all of the equipment seating is to be designed to resist shock loading. Seat design should take account of the acceleration and deceleration from the shock wave; the magnitude of the shock acceleration will depend on the equipment mass, position in the ship and mounting arrangements. The seat design methodology is to be agreed with the relevant Naval Authority. The selection of seats to be assessed will depend on the equipment supported and the compartment in which it is situated.

5.6.2 Minor seats should be assessed to ensure that equipment remains captive. Detail design requirements such as minimum thickness, alignment, and free edge support can be specified to improve shock performance. In the absence of information from the Naval Authority, minor seats can be considered as those with equipment mass below 100 kg.

5.6.3 Seats which are not classed as minor are to be assessed for shock loads using acceleration values appropriate to the region of the ship in which the equipment is installed. Large items of equipment where the seat is integrated into the ship's structure will normally require a finite element analysis to assess the strength of the seat. Where these seats are adjacent to the hull or an integrated tank, the fluid structure interaction may need to be modelled. *See* 5.4.

5.6.4 The shock accelerations are to be agreed between the Owner, designer and Naval Authority. In general, accelerations will be specified for the following regions of the ship:

(a) within 2,0 m of the wetted hull;
(b) main transverse bulkheads and decks below the strength deck;
(c) above strength deck and superstructures.

Shock accelerations can be scaled using a factor for different equipment based on its category of use.

5.6.5 For each equipment seat to be assessed, a report is to be provided containing the following information:

(a) equipment mass and centre of gravity;
(b) location in vessel;
(c) mounting system;
(d) spatial clearances around the mounted equipment;
(e) captivity requirements;
(f) relevant excitation frequencies from mounted equipment in the case of reciprocating or rotational machinery;
(g) calculations demonstrating maximum stress and displacement, under vertical acceleration, vertical deceleration and athwartships accelerations. For non-linear analyses, strain rates are to be provided;
(h) equipment alignment requirements, as appropriate.

5.6.6 As a minimum, the following seat load cases are to be assessed:

(a) bolts; pull through, tensile, shear and bearing strength;
(b) seat flange; flange bending and top plate weld area;
(c) seat web; buckling and overturning;
(d) deck; seat weld area if less than flange.

5.6.7 Stress and strain are to be assessed against criteria appropriate for the seat material and loading rate. In the absence of specific information, for steel, a stress factor $f\sigma = 1,3$ can be used for high acceleration shock loads and $f\sigma = 1,0$ for other shock loads.

5.7 Shock mounts

5.7.1 All shock mounts are to be of an approved type. Approval is to be undertaken by organisations approved by the Naval Authority. Approval documentation should contain the following information in accordance with NATO document ANEP63:

(a) nature and application of the mount, including generic type, application, load range, shock displacement, environmental constraints and frequency range;
(b) description of the mount assembly, including the complete assembly, the mount and the associated components;
(c) details of the mount standard assembly and installation;
(d) physical size, mass and dimensions;
(e) performance data as listed in Table 5.8.1;
(f) details of the mount testing process, including method of force generation, number of mounts used/shots used, mount supplier, validation, mount permanent deflection, details of test facility and date of testing;
(g) mount specific protection, installation, inspection and maintenance requirements;
(h) any applicable historic data, i.e., changes to the mount details over time. For example, changes of material, etc.

Table 5.8.1 Shock mount characterisation

Mount size number			1
Nominal load		kg	
Static stiffness	Vertical V	N/m	
	Horizontal H_A	N/m	
	Horizontal H_R	N/m	
Dynamic stiffness	Vertical V	N/m	
	Horizontal H_A	N/m	
	Horizontal H_R	N/m	
% of critical damping			
Vertical static displacement at nominal load		mm	
Natural frequencies	Vertical V	Hz	
	Horizontal H_A	Hz	
	Horizontal H_R	Hz	
Dynamic magnification at resonance		—	
Shock displacement capacity	Vertical V	mm	
	Horizontal H_A	mm	
	Horizontal H_R	mm	
Maximum transmitted acceleration at nominal load	Vertical V	m/s^2	
	Horizontal H_A	m/s^2	
	Horizontal H_R	m/s^2	
Range of validity of mount surface/best fit governing equation (where applicable) relative to unloaded condition		±mm	
Required support stiffness		N/m	
Required support strength		N	

5.8 Hull valve design guidance

5.8.1 Hull valves below the waterline are to be of an approved type. Approval is to be undertaken by organisations approved by the Naval Authority. Approval documentation should contain the following:

(a) details of the valve body, main components and securing arrangement to the hull, including bolt material grade and tightening torque;
(b) details of the valve testing process, including method of force generation, number of tests, validation, details of test facility and date of testing.

5.8.2 Only materials with sufficient ductility to avoid fracture under shock conditions are to be used. Materials should be able to withstand high stresses for very short periods without exhibiting brittleness. Valve bodies are not to be made from materials with an elongation of less than 10 per cent. There should be adequate material in way of the valve seat to prevent distortion.

5.8.3 In general, the valve body should be as symmetrical as possible with no rapid changes in section; web stiffeners should not be incorporated. Spindles should be as short as possible. Square threads or sharp thread run-outs are to be avoided. Handwheels should be as light and small as possible.

Volume 1, Part 4, Chapter 2 & Part 6, Chapter 3

5.8.4 The weight of the actuator is to be considered in the design of the valve and its connection to the hull. The actuator can form a considerable proportion of the overall weight of the valve.

5.8.5 Consideration should be given to the attached piping and its capacity to withstand shock. Flanged and welded connections are to be used adjacent to the hull valve. Adjacent piping is to be designed to allow the valve and hull to flex under shock with limited restraint.

5.8.6 The sealing arrangement between the valve and the hull insert is to be suitable for shock loading and able to accommodate elongation of the securing studs.

5.8.7 Hull valve designs can be approved by the following methods:
(a) physical testing;
(b) semi-empirical methods;
(c) direct calculation.

5.8.8 Physical shock testing may be used to assess the valve. Physical testing is to take account of the attachment to the hull and possible combinations of hull scantlings, stiffener spacing, materials, etc.

5.8.9 Recognised semi-empirical methods may be used to assess the valve and should be agreed between the Owner, the Naval Authority and the Shipbuilder.

5.8.10 Validated numerical methods may be used to assess the valve. Where used, they are to take account of the following criteria:
(a) asymmetry in the valve and piping assembly;
(b) dimensions of the hull insert/pad;
(c) use of sea tube between the valve and hull insert;
(d) hull scantlings and stiffener/frame spacing;
(e) plasticity in the hull and valve assembly;
(f) the effective mass of the valve, actuator and piping;
(g) the valve to hull securing arrangement, taking into account fit and pre-stress effects;
(h) dynamic properties of materials;
(j) the effect of any surrounding equipment or masses.
Sea tubes of unusual material, GRE for example, or unusual configuration are to be assessed by physical shock testing and not assessed by numerical simulation.

Volume 1, Part 6, Chapter 3
Scantling Determination

Effective date 1 January 2012

■ *Section 12*
Pillars and pillar bulkheads

12.3 Design loads

12.3.1 The design loading, ~~P_{pi}~~, L_{pi}, to be used in the determination of pillar scantlings is as follows:

~~P_{pi}~~ L_{pi} = $S_{gt}\, b_{gt}\, P_c + L_a$ kN

where

~~P_p~~ L_{pi} = design load supported by the pillar, to be taken as not less than 5 kN

P_c = basic deck girder design pressure, as appropriate, plus any other loadings directly above the pillar, in kN/m^2

L_a = load from pillar or pillars above, assumed zero if there are no pillars over, in kN

S_{gt} = spacing, or mean spacing, of girders or transverses, in metres

b_{gt} = distance between centres of two adjacent spans of girders or transverses supported by the pillar, in metres.

12.4 Scantling determination

12.4.1 The minimum wall thickness of tubular pillars is to be in accordance with Section 2.

(*Part only shown*)
12.4.2 The cross-sectional area of the pillar, A_p, is not to be less than:

$$A_p = 10\, \cancel{\frac{P_{pi}}{\sigma_p}}\, \frac{L_{pi}}{\sigma_p} \text{ cm}^2$$

where

~~P_{pi}~~ L_{pi} = design load, in ~~KN~~ kN, supported by the pillar as determined from 12.3

12.7 Pillar bulkheads

12.7.2 The cross-sectional area of the pillar bulkhead, A_{pb}, is to be determined in accordance with 12.4 using the design loading, ~~P_{pb}~~ L_{pb}, as follows:

~~P_{pb}~~ L_{pb} = $S_{pb}\, B_{pb}\, P_c + L_c + L_p + L_a$ kN

where

~~P_{pb}~~ L_{pb} = design load supported by the stiffener plate combination of the pillar bulkhead, to be taken as not less than 5 kN

P_c = basic deck girder design pressure, as appropriate, ~~plus any other loadings directly above the pillar,~~ directly above the pillar bulkhead, in kN/m^2

L_c = point loads applied to load area supported by the pillar bulkhead, and not included in P_c, in kN
Point loads supported by the pillar bulkhead which should include point loads within the load patch plus point loads from outside the load patch, which distribute to the pillar bulkhead. Point loads which fall between pillar bulkheads should be shared proportionately between support points
L_p = load resulting from uniformly distributed loads on decks above, excluding the deck directly above, which have been carried through by pillars or pillar bulkheads above, in kN
L_a = ~~load, in kN, from pillar or pillars above, assumed zero if there are no pillars over~~
= point load, in kN, from above
= zero if there are no pillars or pillar bulkheads over
= 65 per cent of the point load from pillar bulkhead over, provided the pillar bulkhead spans between primary support points
= full load from pillar or pillars over
= full load from pillar bulkhead or pillar bulkheads over that do not span between primary support points
S_{pb} = spacing, or mean spacing, of bulkheads or effective transverses/longitudinal stiffeners, in metres
B_{pb} = distance between centres of two adjacent spans of girders or transverses supported by the pillar bulkhead, in metres, and can be taken as the distance between pillar bulkhead stiffeners where the stiffeners at the top of the bulkhead effectively distribute~~s~~ the load evenly into the stiffeners.

12.7.4 The scantlings of the pillar bulkhead are not to be less than those of any bulkhead or pillar bulkhead in the direct support line above that being considered.

12.8 Direct calculations

12.8.1 As an alternative to 12.4 and 12.7, pillars and pillar bulkheads may be designed on the basis of direct calculation. The method adopted and the stress levels proposed for the material of construction are to be submitted together with the calculations for consideration.

Volume 1, Part 6, Chapter 4

Hull Girder Strength

CORRIGENDA

■ *Section 4*
Residual Strength Assessment, RSA

4.4 Bending strength – Simplified assessment method RSA1

(*Part only shown*)
4.4.1 If the simplified analysis method is adopted for residual strength assessment, the longitudinal strength of the ship at each critical section is to satisfy the following criteria for the hogging and sagging conditions:

Z_{DRS} = actual section modulus at deck of damaged section, in m^3, *see also* ~~4.1.13~~ 4.1.8
Z_{BRS} = actual section modulus at keel of damaged section, in m^3, *see also* ~~4.1.13~~ 4.1.8
f_{hts} and σ_o are defined in 1.3.1.

4.5 Shear strength – Simplified assessment method RSA1

(*Part only shown*)
4.5.1 If the simplified analysis method is adopted for residual strength assessment, the shear strength of the ship after damage at each damaged critical section is to satisfy the following criterion:

A_z, I and δ_i are to be calculated in accordance with the method in 2.3 for the damaged section, *see also* ~~4.1.13~~ 4.1.8.
f_{hts} and τ_o are defined in 1.3.1.

4.6 Bending and shear strength – Ultimate strength analysis method RSA2

(*Part only shown*)
4.6.1 The residual strength capability of the damaged hull girder may be assessed using a direct calculation ultimate strength analysis method. In this case the longitudinal strength of the ship at each critical section is to satisfy the following criteria for the hogging and sagging conditions:

M_{URS} = ultimate bending strength of the damaged critical section, in kNm, *see also* ~~4.1.13~~ 4.1.8

Volume 2, Part 1, Chapter 1

General Requirements for Classification of Engineering Systems

Effective date 1 January 2012

■ *Section 6*

Routes to conformance

6.11 Alternative arrangements and calculation methods

6.11.1 In addition to cases where direct calculations are specifically required by the Rules, LR will consider alternative arrangements that have been derived by direct calculations in lieu of specific Rule requirements. All direct calculations are to be submitted for examination.

6.11.2 Where items are of a novel or unconventional design or manufacture, it is the responsibility of the designer to demonstrate their suitability and equivalence to the Rule requirements. *See Requirements for Machinery and Engineering Systems of Unconventional Design*, Vol 2, Pt 1, Ch 5.

6.11.3 Alternative arrangements or fittings that are considered to be equivalent to the Rule requirements will be accepted in accordance with Vol 1, Pt 1, Ch 2,3.11.

Volume 3, Part 1, Chapter 4

Manoeuvring Assessment

CORRIGENDUM

■ *Section 4*

Verification trials

4.2 Environmental restrictions

4.2.1 The verification trials are to take place in deep, unconfined waters, to minimise the interactive effects of the sea bed topography. The environmental conditions are to be as follows:

LMA notation:

- The water depth is not to be less than four times the mean operational draught of the ship.
- The wind speed should not exceed Beaufort 5.
- The wave sea state should not exceed 4.

LNMA notation:

- The water depth is not to be less than 5 times the mean operational draught of the ship or ~~0,0747V2~~ $0{,}0747V^2$, whichever is greater.
- The wind speed should not exceed 15 knots.
- The wave sea state should not exceed 3.
- In both cases heavy swell is to be avoided.

Volume 3, Part 1, Chapter 5

Replenishment at Sea (RAS) Systems

CORRIGENDUM

■ *Section 1*

General requirements

1.3 Safety

(*Part only shown*)

1.3.1 Replenishment at sea between two vessels underway (particularly abeam RAS) is classified as the most hazardous peacetime seamanship evolution conducted by the naval and supply ships. It is important that the following areas are considered when designing, building, operating and maintaining RAS systems:

(b) **Handling of Explosives and Bulk Ammunition**: Replenishment of solids may include ammunition and explosives classified as UN hazard category 1~~.1~~. Particular note is to be taken of the enhanced factors of safety and equipment test periodicities that are required for mechanical handling equipment used for such purposes.

Volume 3, Part 3, Chapter 1

General Requirements

Effective date 1 January 2012

■ *Section 1*
Scope

1.1 Application

~~*1.1.3* For the purpose of the application of this Part of the Rules, 'in accordance with' and 'equivalence/equivalent' are understood as: Acceptance of any fitting, material, apparatus, arrangement or type thereof required by these Rules if LR is satisfied that such fitting, material, apparatus or arrangement, or type thereof, meets the Objectives specified in these Rules.~~

Existing paragraphs 1.1.4 *to* 1.1.7 *have been renumbered* 1.1.3 *to* 1.1.6.

1.4 Topics within this Part of the Rules

1.4.8 **Double Star Endorsements (★★)**. All Class Notations that are available in Chapters 2, 3 and 4 of this Part of the Rules will be eligible for a 'Double Star' endorsement where the arrangements on board are in accordance with stated ~~National Administration~~ Naval Authority requirements and *ANEP-77 NATO Naval Ship Code* (NSC). This does not necessarily denote automatic endorsement by the ~~National Administration~~ Naval Authority.

■ *Section 2*
General information

2.1 Responsibilities

2.1.4 The **~~National Administration~~** **Naval Authority** is responsible for confirming that the equipment and arrangements are acceptable to them for recognition of the requirements associated with a particular class notation with a ~~double star~~ Double Star (★★) endorsement, *see* 1.4.8.

2.2 Appraisal and review

2.2.3 All systems are to be constructed and assembled from equipment suitable for its intended purpose and acceptable to the ~~Naval Authority~~ National Administration and/or the ~~National Administration~~ Naval Authority where a 'Star' or 'Double Star' endorsement is required. Such equipment will typically have a relevant Type Approval Certificate or an EC Marine Equipment Directive Certificate issued by LR or an organisation acceptable to LR. Equipment with other certification may be acceptable as an alternative subject to a satisfactory review by LR. Details will be noted as an Annex in the applicable certification or class documentation, *see* 1.3.1.

■ *Section 6*
Route to conformance

6.1 Route to conformance

~~*6.1.4* At each stage in the process there may be occasions where the prescriptive requirements cannot be met. Where the reasons for non-compliance have a military justification, conformance is to be managed through one of the following:~~

~~(a) **Concession**. A concession may be granted at the discretion of an authorised LR Surveyor. The concession is only granted where the Surveyor considers the deviation not to effect the overall design philosophy of the Rules. The concession will be recorded in the Annex to the Certificate of Compliance or Classification Records as applicable.~~

~~(b) **Alternative design justification**. An alternative design justification report is required to be developed in accordance with the Naval Survey Guidance where the LR Surveyor considers the deviation to be of a critical or significant nature to be assessed on judgement alone. Following a satisfactory review of the report, LR will issue a letter of acceptance. The letter of acceptance and principal details from the report will be recorded in the Annex to the Certificate of Compliance or Classification records as applicable.~~

6.2 Alternative arrangements and calculation methods

6.2.1 In addition to cases where direct calculations are specifically required by the Rules, LR will consider alternative arrangements that have been derived by direct calculations in lieu of specific Rule requirements. All direct calculations are to be submitted for examination.

6.2.2 Where items are of a novel or unconventional design or manufacture, it is the responsibility of the designer to demonstrate their suitability and equivalence to the Rule requirements. *See Requirements for Machinery and Engineering Systems of Unconventional Design*, Vol 2, Pt 1, Ch 5.

6.2.3 Alternative arrangements or fittings that are considered to be equivalent to the Rule requirements will be accepted in accordance with Vol 1, Pt 1, Ch 2,3.11.

Volume 3, Part 3, Chapter 6

Pollution Prevention

CORRIGENDUM

■ *Section 5*

Prevention of pollution by sewage and pollution of the air from ships

5.1 Regulations of MARPOL Annex IV (Sewage Pollution)

5.1.1 Where required by the Naval Authority, all regulations of MARPOL Annex IV are to be complied with. ~~This Annex is yet to be ratified at IMO.~~

© Lloyd’s Register, 2011
Published by Lloyd’s Register
Registered office
71 Fenchurch Street, London, EC3M 4BS
United Kingdom